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**ONLINE DATABASES : WPI**

## (54) Mooring systems

(57) In a mooring system for tanker vessels at offshore oil fields of the kind in which a flexible riser pipe 4 connected to an underwater well head 1 is supported by an anchored mooring buoy 3 and is connectable to a tanker vessel, the buoy 3 comprises a body member 14 non-rotationally moored at sea bed below the surface of the sea, and supports a surrounding ring member carrying a mooring hawser 11 and rotatable about a vertical axis, the riser pipe 4 passing through an opening 21 in the body member 14. Such an arrangement allows substantial rotation of the tanker around the subsea buoy to permit it to weathervane in dependence upon wind and tide conditions. The ring member is formed from a number of blocks 17 and intervening links 18.

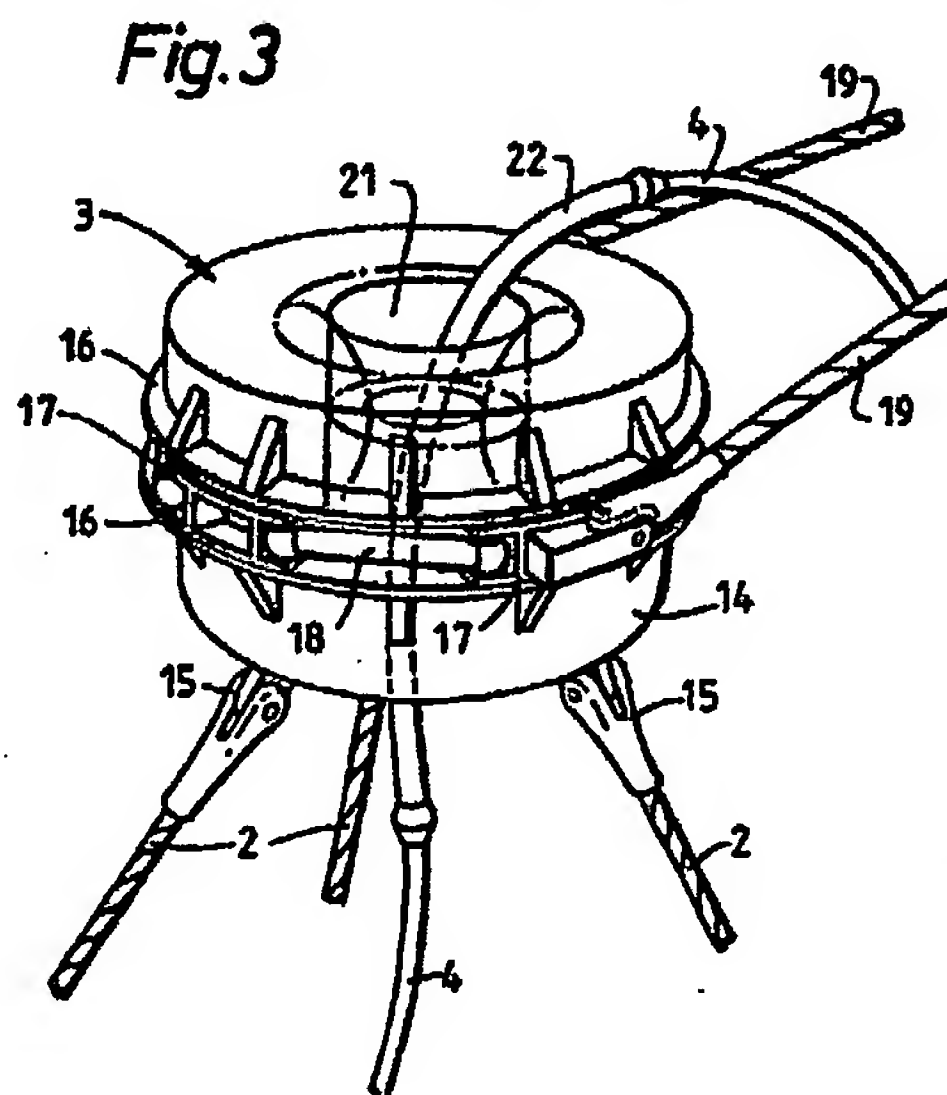
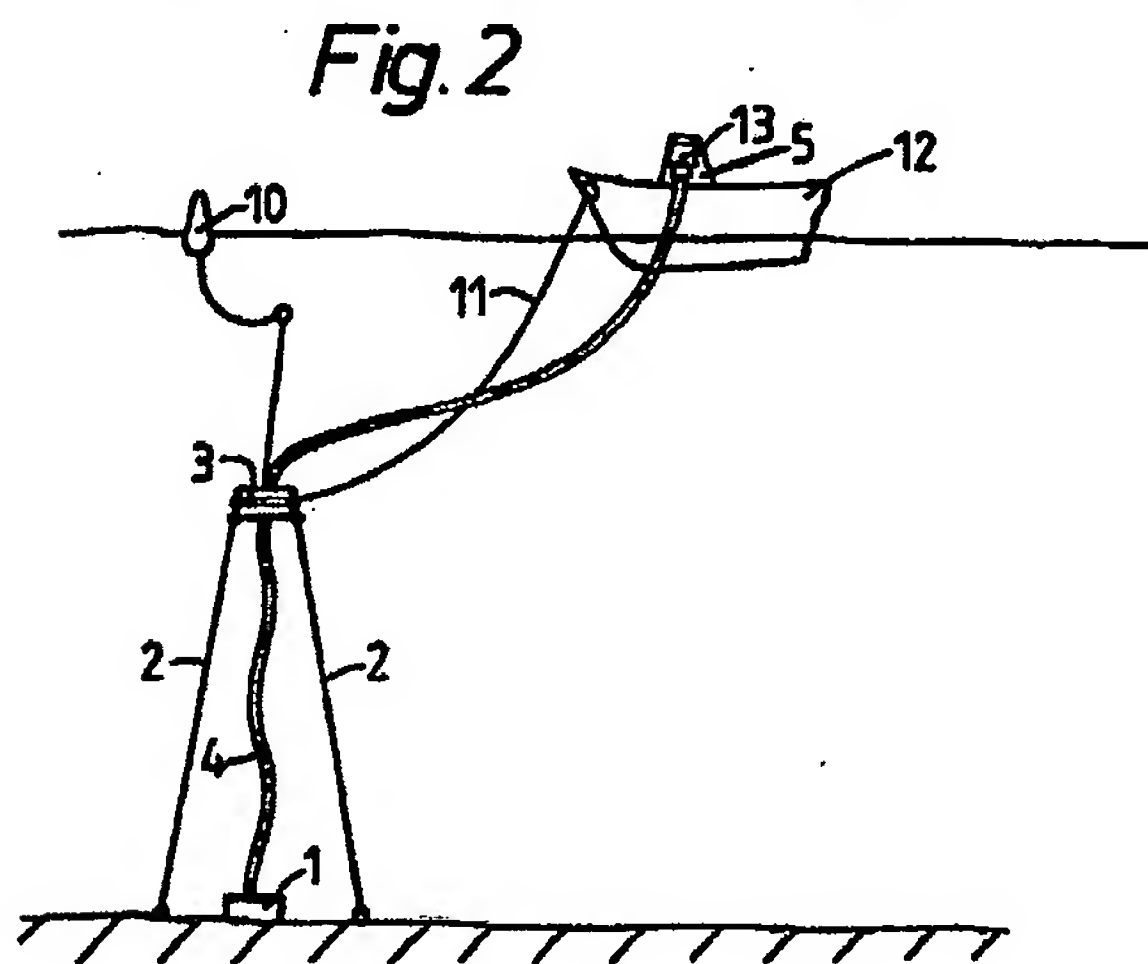


Fig. 1

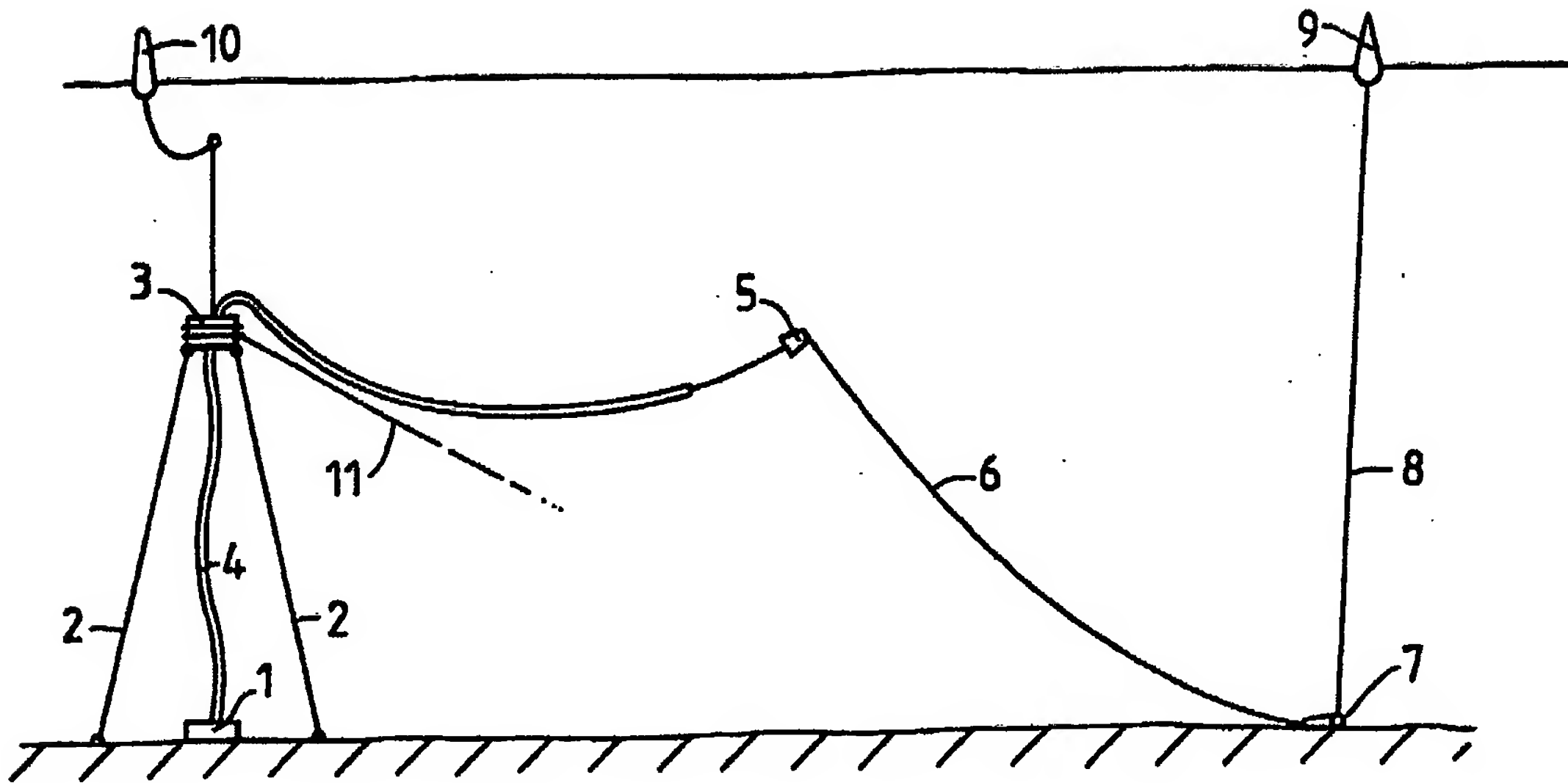
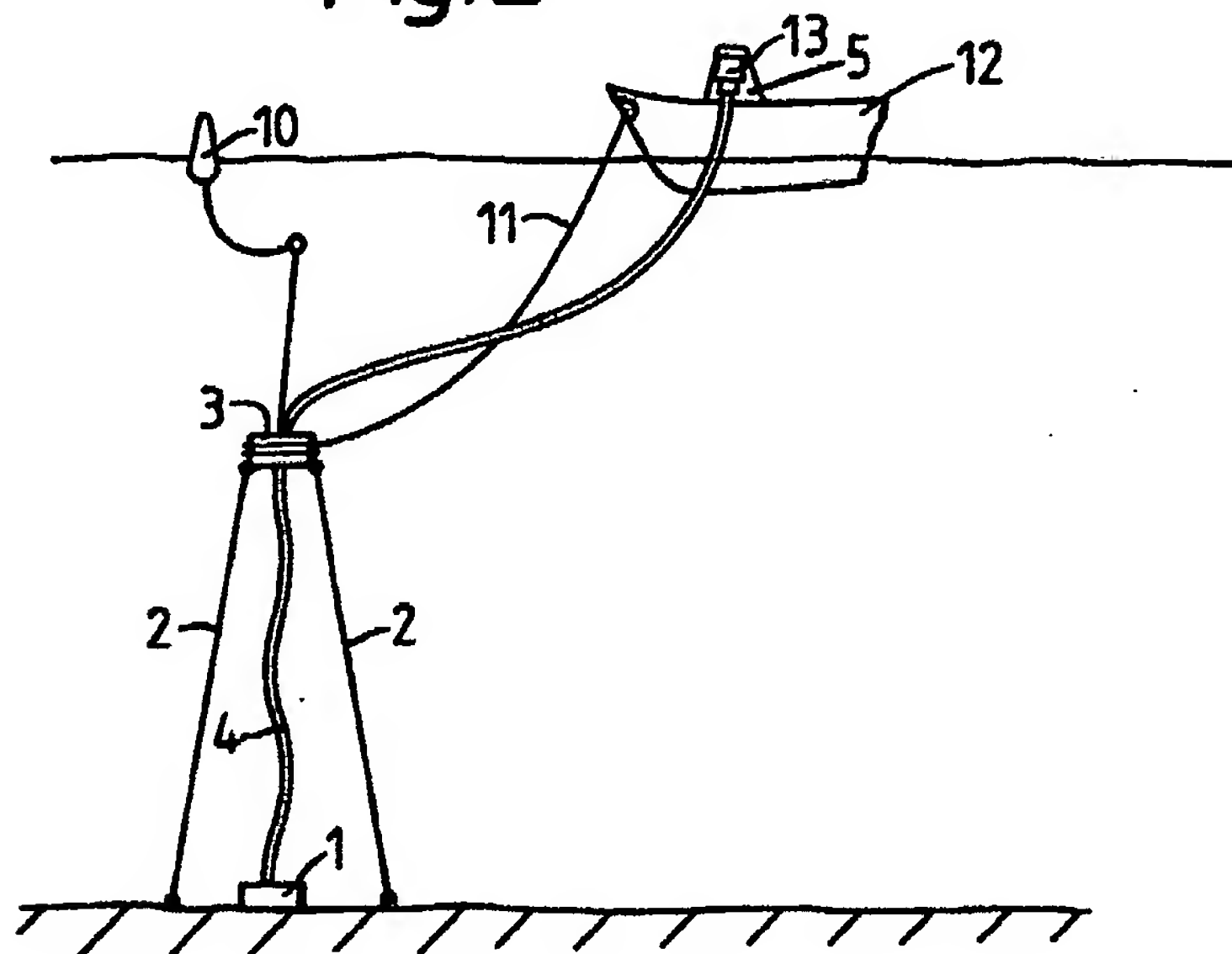
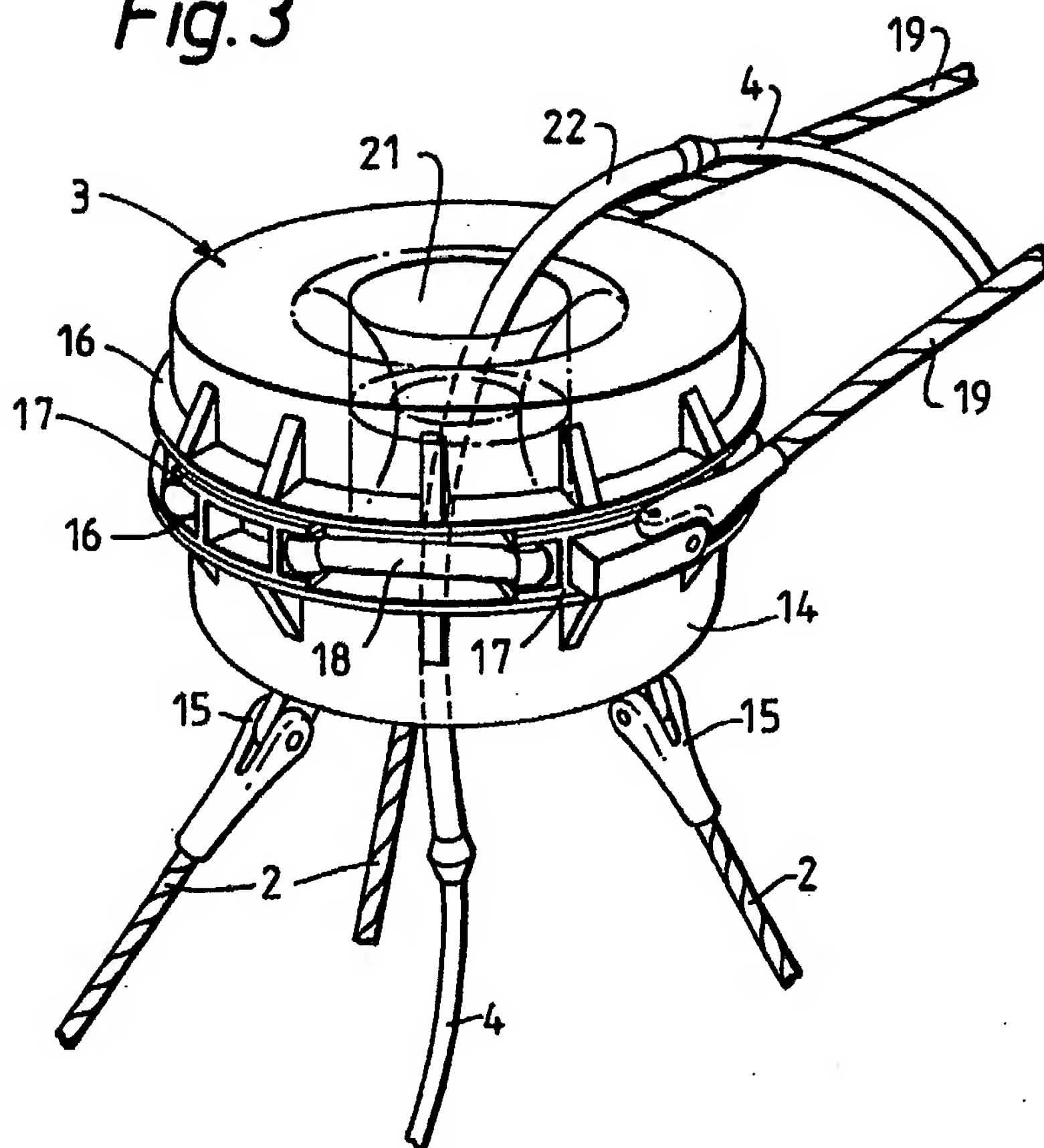
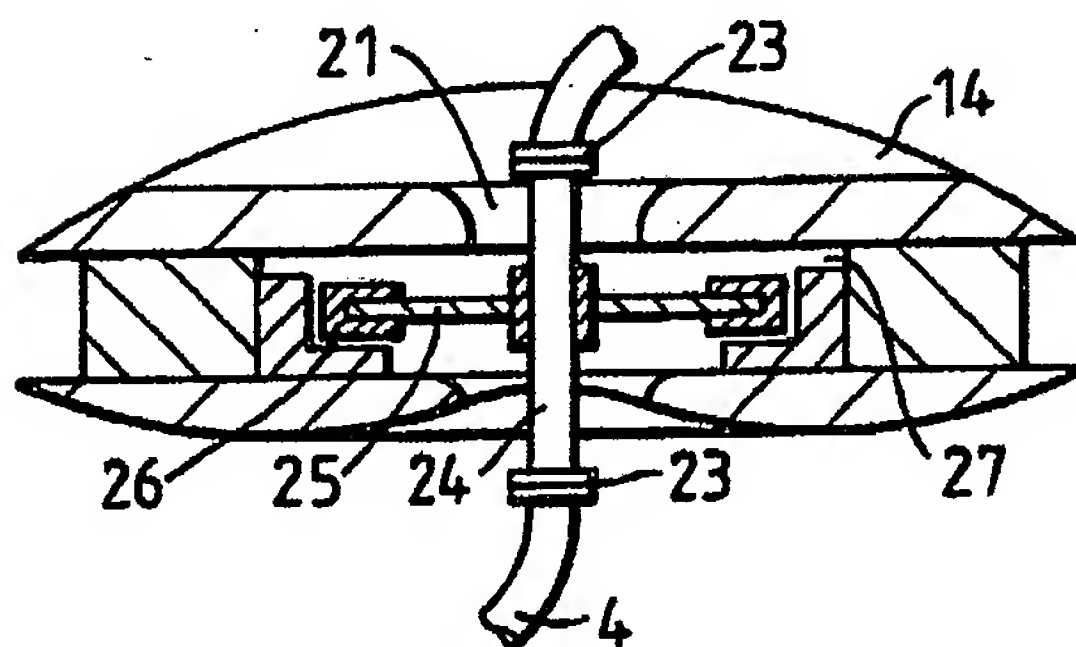


Fig. 2



*Fig. 3**Fig. 4*

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MOORING SYSTEMS

This invention relates to a mooring system for tanker vessels at offshore oil fields of the kind in which a flexible riser pipe connected to an underwater well head is supported by an anchored mooring buoy, and is connectable to a tanker vessel to enable oil to be transferred from the well head to the vessel.

In one form of such a mooring and oil transfer system the buoy is anchored to the sea-bed below the surface of the sea and carries a mooring hawser connected at its free end to a pick-up line supported by a floating buoy to enable a vessel to retrieve and engage the mooring hawser, the flexible riser pipe or an extension thereto extending from the buoy and being similarly connected to the or an individual pick-up line to permit retrieval and connection to a co-operating coupling member on the vessel.

In some cases it is necessary for the tanker to be continuously held on station under power, and this is clearly undesirable, and an object of the invention is to provide a form of "passive" mooring system which permits a degree of rotation of a moored tanker around the subsea buoy.

According, therefore, to the invention, in a mooring system of the kind referred to incorporating an anchored mooring buoy, the buoy comprises a body member arranged to be non-rotationally moored to the sea-bed below the surface of the sea, a ring member

rotationally supported by the body member so as to enable it to revolve about a vertical axis when the buoy is moored in its operational position, and a mooring hawser connected to the ring member, the body member having an opening extending through it coaxial with the ring member through which the riser pipe passes.

Such an arrangement allows substantial rotation of the tanker around the subsea buoy to permit it to weathervane in dependence upon wind and tide conditions.

By the use of a swivel connection between the flexible riser pipe and the coupling on the tanker wind-up of the riser pipe can be countered, so permitting continuous rotation of the tanker.

Preferably the ring member runs in a track formed around the outside of the body member, a water lubricated necklace bearing facilitating easy rotation of the ring.

The body member is conveniently anchored to the sea-bed by means of a plurality of mooring lines spaced around the well-head, although three spaced mooring lines is a preferred arrangement. The anchoring points for the mooring lines are preferably spaced uniformly around the well-head.

The flexible riser pipe may be provided with a protective sleeve where it passes through the opening in the body member to avoid damage due to abrasion. Alternatively that section of the riser pipe may be secured within a support member which is itself rotatable within the opening in the body member.

Two embodiments of the invention will now be described by way of example with reference to Figures 1 to 4 of the accompanying schematic drawings, in which

Figure 1 illustrates the general arrangement of a mooring system in accordance with the invention, prior to retrieval of the mooring hawser and riser pipe by a tanker vessel,

Figure 2 shows the arrangement following the retrieval of the mooring hawser and riser pipe by the vessel,

Figures 3 and 4 illustrate alternative forms of mooring buoy for use in the system.

Referring first to Figure 1, this shows diagrammatically, and not to scale, a well head 1, above which is secured, by means of

three spaced mooring lines 2 (only two of which are shown), a subsea buoy 3 at about two thirds water depth.

A flexible riser pipe 4 extends upwards from the well head and passes, as will subsequently be explained, through a vertically extending opening in the buoy 3 and, being fitted with flotation where required, extends in catenary fashion from the buoy. The terminal end of the riser pipe 4 is fitted with a coupling member 5 which is secured to a pick-up line 6 attached to an anchor 7 on the sea-bed, and a line 8 from the anchor extends upwards to a floating pick-up buoy 9. A further floating marker buoy 10 connected to the subsea buoy 3 indicates the position of the well head.

The coupling member 5 incorporates a valve which forms a closure at the end of the riser pipe until the member is connected to a co-operating coupling member on a tanker vessel.

A mooring hawser 11 attached to the subsea buoy 3, and shown only in part, is similarly attached to a pick-up line which has been omitted from the drawing for simplicity. The length of the riser pipe 4 between the well head 1 and the buoy 3 is greater than the vertical distance between them in order to reduce stresses on the pipe.

In Figure 2 the mooring hawser 11 and the flexible riser pipe 4 have been retrieved by a tanker vessel 12, and secured to it, the riser pipe coupling member 5 being connected to a swivel coupling 13 the purpose of which will be subsequently explained.

One form of subsea mooring buoy for use in the system above described is illustrated in Figure 3. The buoy 3 comprises a cylindrical body member 14 having anchoring points 15 for the three mooring lines 2 which are splayed outwards to clear the riser pipe 4. The body member 14 carries a pair of radially extending annular flanges 16 forming between them an annular track in which is fitted a ring formed from a number of blocks 17 and intervening links 18 for facilitating assembly. The blocks are faced internally with a water lubricating material so that the ring is effectively in the form of a water lubricated necklace bearing and thus rotates easily around the track of the body member 14.

Two diametrically opposed blocks 17 incorporate anchoring

points for the attachment of two bridle wires 19 connected at their opposite end to the mooring hawser 11.

The body member 14 has a vertically extending opening 21 for the passage of the flexible riser pipe 4, the pipe being protected against abrasion where it passes through the opening 21 by an external sleeve 22 or by other protection devices.

With such an arrangement the tanker is enabled to rotate continuously around the mooring buoy, wind-up of the riser pipe being countered by the swivel coupling 13 on the tanker. The swivel coupling is conveniently powered, and emergency breakaway facilities for the riser pipe and mooring hawser are provided on the tanker in the customary way.

In a modification of the mooring buoy illustrated in section in Figure 4, the flexible riser pipe 4 is broken above and below the body member 14 and is connected by liquid tight joints 23 to a rigid section 24 which extends through the opening 21 in the body member. The riser pipe section 24 is fixed centrally within a carrier 25 in the form of a wheel whose rim 26 is rotatable within bearings of any suitable kind in a circular channel 27 within the body member 14. To permit assembly of the carrier the body member in this embodiment is made in separate sections as shown. The outer ring to which the bridle wires 19 are connected have been omitted from this figure for simplicity, but are similar to those illustrated in Figure 3.



CLAIMS

1. A mooring system for tanker vessels at offshore oil fields of the kind in which a flexible riser pipe connected to an underwater well-head is supported by an anchored mooring buoy, and is connectable to a tanker vessel to enable oil to be transferred from the well-head to the vessel, wherein the buoy comprises a body member arranged to be non-rotationally moored to the sea-bed below the surface of the sea, and the system incorporates a ring member rotationally supported by the body member so as to enable it to revolve about a vertical axis when the buoy is moored in its operational position, and a mooring hawser connected to the ring member, the body member having an opening extending through it coaxial with the ring member through which the riser pipe passes.
2. A mooring system according to Claim 1 wherein the ring member runs in a track formed around the outside of the body member.
3. A mooring system according to Claim 2 wherein the ring member comprises a water lubricated necklace bearing.
4. A mooring system according to Claim 1, 2 or 3, wherein the body member is anchored to the sea-bed by a plurality of mooring lines spaced around the well-head.
5. A mooring system according to Claim 4, wherein there are three said mooring lines.
6. A mooring system according to Claim 4 or Claim 5, wherein the anchoring points for the mooring lines are spaced uniformly around the well-head.
7. A mooring system according to any preceding claim wherein the flexible riser pipe is provided with a protective sleeve where it passes through the opening in the body member to avoid damage due to abrasion.
8. A mooring system according to any one of Claims 1 to 5 wherein the section of the riser pipe which passes through the opening in the body member is secured within a support member which is itself rotatable within the opening in the body member.
9. A mooring system for tanker vessels at offshore oil fields substantially as shown in and as hereinbefore described with reference to Figures 1 to 3, or Figures 1, 2 and 4 of the accompanying drawings.



**Patents Act 1977**  
**Examiner's report to the Comptroller under Section 17**  
**(The Search report)**

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**Relevant Technical Fields**

- (i) UK Cl (Ed.L) B7V (VFA, VFB)  
 (ii) Int Cl (Ed.5) B63B 21/00, 21/50, 22/00, 22/02

Search Examiner  
 A HABBIIAM

Date of completion of Search  
 29 NOVEMBER 1993

Databases (see below)  
 (i) UK Patent Office collections of GB, EP, WO and US patent specifications.

Documents considered relevant following a search in respect of Claims :-  
 1-9

(ii) ONLINE DATABASES: WPI

**Categories of documents**

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| <p><b>X:</b> Document indicating lack of novelty or of inventive step.</p> <p><b>Y:</b> Document indicating lack of inventive step if combined with one or more other documents of the same category.</p> <p><b>A:</b> Document indicating technological background and/or state of the art.</p> | <p><b>P:</b> Document published on or after the declared priority date but before the filing date of the present application.</p> <p><b>E:</b> Patent document published on or after, but with priority date earlier than, the filing date of the present application.</p> <p><b>&amp;:</b> Member of the same patent family; corresponding document.</p> |
|--|---|

Category	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1312544 (SNAM PROGETTI) See mooring lines 22 connected to rotatable turntable 12 on buoy 1, Figures 1 and 2	1

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).